REMARKS

Claims 1-14 remain pending after amendment.

Claim Amendments

By this amendment, editorial amendments are made in claims 6 and 11. New claims 13 and 14 are added, directed to subject matter deleted from claims 6 and 11. Claim 5 is amended to clarify the identity of the pseudohalogen, support for which resides at page 11, line 3 of the specification. No new matter is added by this amendment.

Rejection under 35 USC 112 (paragraph two)

Claims 5, 6 and 8-12 stand rejected under 35 USC 112 (paragraph two) as not distinctly claiming the invention. This rejection is respectfully traversed to the extent deemed to apply to the claims as amended.

In response, claim 5 is amended to state that the recited pseudohalogen is thiocyanate or cyanate consistent with the disclosure at page 11, line 3 of the specification. The objection to the use of the term pseudohalogen is thus moot.

Claims 6 and 11 are amended to delete the "preferred" embodiments. The deleted "preferred" embodiments are now incorporated into new claims 13 and 14.

The Examiner questions the intent of the limitation "C_2-C_6 alkoxyalkyl group". In response, applicant submits that it is clear that the C_2-C_6 limitation is intended to define the number of carbon atoms on the alkoxyalkyl group, as opposed to either the alkoxy portion or the alkyl portion. The recited limitation is accordingly believed to comply with the requirements of the statute.

The Examiner objects to the limitation "non-solvent" in claims 8-10. In response, applicant submits that this is an art-recognized term, the meaning of which is clear to one of ordinary skill in the art. Indeed, the function of the recited "non-solvent" is explained at claim 8; i.e., "wherein the organic starch ester is separated from the solution by adding a non-solvent for the organic starch ester to precipitate the organic starch ester." This is explained by the fact that the organic starch ester is not soluble in the non-solvent (see page 12, lines 11-18 of the specification). The term "non-solvent" should accordingly be found to comply with the requirements of the statute.

The Examiner also objects to the limitation "carboxylic acid or a reactive derivative thereof" at claims 11 and 12. In response, applicant states that this language would also be well understood by one of ordinary skill in the art. Further, the specification amply describes the meaning of this limitation at page 11, line 23 to page 12, line 3. This limitation should accordingly be found to fully comply with the requirements of the statute.

The rejection is accordingly believed to be without basis and should be withdrawn.

Rejection under 35 USC 103(a)

Claims 1-12 stand rejected under 35 USC 103(a) as being unpatentable over Nobuo et al and Swatloski et al.

In support of the rejection, the Examiner states at page 5 of the Action that:

> "It would have been obvious to one of ordinary skill in the art at the time the invention was made to esterify starch using the ionic liquids taught by Swatloski et al and water sensitive reagents such as acid halides and acid anhydrides, as taught by Nobuo et al. Derivatization of polysaccharides using acid halides or acid anhydrides in ionic liquids is known in the art, as taught by Nobuo et al. The skilled artisan could have used the guidance provided by Swatloski et al to optimize specific conditions for esterification of starch because starch and cellulose are both glucose polymers and thus esterification

> would be expected to proceed similarly on either. Neither Nobuo et al nor Swatloski et al teach the use of pressure for solubilization or derivatization of polysaccharides, but the skilled artisan would understand that solubility, an integral part of the teachings of Nobuo et al and Swatloski et al increases with pressure. Furthermore, pressure is an experimental parameter easily manipulated by the skilled artisan in chemical synthesis."

This rejection is respectfully traversed.

Applicable Legal Standard

To establish a *prima facie* case of obviousness, three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art reference (or references when combined) must teach or suggest all the claim limitations.

The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, not in applicant's disclosure. *In re Vaeck*, 947 F.2d 488, 20 USPQ2d 1438 (Fed. Cir. 1991).

"There are three possible sources for a motivation to combine references: the nature of the problem to be solved, the teachings of the prior art, and the knowledge of persons of ordinary skill in the art." *In re Rouffet,* 149 F.3d 1350, 1357, 47 USPQ2d 1453, 1457-58 (Fed. Cir. 1998).

"In determining the propriety of the Patent Office case for obviousness in the first instance, it is necessary to ascertain whether or not the reference teachings would appear to be sufficient for one of ordinary skill in the relevant art having the reference before him to make the proposed substitution, combination, or other modification." *In re Linter*, 458 F.2d 1013, 1016, 173 USPQ 560, 562 (CCPA 1972).

Obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either explicitly or implicitly in the references themselves or in the knowledge generally available to one of ordinary skill in the art. "The test for an implicit showing is what the combined teachings, knowledge of one of ordinary skill in the art, and the nature of the problem to be solved as a whole would have suggested to those of ordinary skill in the art." *In re Kotzab,* 217 F.3d 1365, 1370, 55 USPQ2d 1313, 1317 (Fed. Cir. 2000). See also *In re Lee,* 277 F.3d 1338, 1342-44, 61 USPQ2d 1430, 1433-34 (Fed. Cir. 2002) (discussing the importance of relying on objective evidence and making specific factual findings with respect to the motivation to combine references); *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988); *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992).

The Supreme Court of the United States has recently held that the teaching, suggestion, motivation test is a valid test for obviousness, but one which cannot be too rigidly applied. See *KSR Int'l Co. v Teleflex Inc.*, No. 04-1350, slip op. at 11 (U.S. April 30, 2007).

The Supreme Court in *KSR Int'l Co. v. Teleflex, Inc.*, No. 04-1350 (U.S. April 30, 2007) reaffirmed the Graham factors in the determination of obviousness under 35 U.S.C. § 103(a). The four factual inquiries under Graham are:

(a) determining the scope and contents of the prior art;

(b) ascertaining the differences between the prior art and the claims in issue;

(c) resolving the level of ordinary skill in the pertinent art; and

(d) evaluating evidence of secondary consideration.

Graham v. John Deere, 383 U.S. 1, 17-18, 148 USPQ 459, 467 (1966).

The Court in *KSR Int'l Co. v. Teleflex, Inc., supra.,* did not totally reject the use of "teaching, suggestion, or motivation" as a factor in the obviousness analysis. Rather, the Court recognized that a showing of "teaching, suggestion, or motivation" to combine the prior art to meet the claimed subject matter could provide a helpful insight in determining whether the claimed subject matter is obvious under 35 U.S.C. § 103(a).

Even so, the Court in *KSR Int'l Co. v. Teleflex, Inc., ibid.,* rejected a rigid application of the "teaching, suggestion, or motivation" (TSM) test, which required a showing of some teaching, suggestion, or motivation in the prior art that would lead one of ordinary skill in the art to combine the prior art elements in the manner claimed in the application or patent before holding the claimed subject matter to be obvious.

Applicant submits that the Examiner fails to present a *prima facie* case of obviousness in relation to the cited prior art.

Distinctions over Nobuo et al and Swatloski et al

Applicant initially notes that the cited references were cited in the International Search Report, and distinguished over in a response filed to the Written Opinion. Those distinctions are repeated below.

Nobuo et al discloses the use of imidazolium salts (ionic liquids at room temperature) as solvent and reaction medium for polysaccharides, namely α-cyclodextrin and agarose, in chemical modification processes using water unstable modifying agents such as acid halides or acid anhydrides from which the subject-matter of claim 1 differs in that method is applied to starch.

The present invention provides a three-step method for preparing an organic starch ester by mixing a starch material with an ionic liquid to dissolve the starch, and then treating the dissolved

starch material with an organic esterifying agent to form an organic starch ester, and subsequently separating the organic starch ester from solution.

Starch is composed of two different type of molecules, namely amylopectin and amylase. Of these, amylose is a linear (1,4)- a-Dglucan, while amylopectin is a branched, bushlike structure containing both (1,4)- a-linkages between D-glucose residues and (1,6)- a-D branch points. Normal starches contain approximately 75% of amylopectin molecules, the rest consisting of amylose. In addition to chemical structure, amylopectin differs from amylose dramatically also in molecular size. Amylopectin is an incredibly large polymer with molecular masses from one to several million, while linearly structured amylose is considerably smaller, the molecular masses falling in the range of 5000 to 200,000.

Due to their extremely high molecular masses (especially of the amylopectin fraction), starch is known to be practically insoluble in solvents other than water. Esterification reactions in turn require anhydrous reaction conditions, which lead to well-known problems described also in the present application (see pages 4-5). Generally, the present methods result in sluggish and ineffective heterogeneous reaction conditions giving low degrees of substitution of the starch esters. Further, prolonged reaction times, elevated reaction temperatures and required catalysts cause inevitably chain degradation of both starch starting material and the product formed. Further, additional chemicals complicate the product separation process resulting simultaneously in lower yields of starch esters and increased volumes of waste material.

The poor or non-existing solubility of starch is presently enhanced by pre-hydrolyzing the starch to smaller molecules such as hydrolyzed starch having radically lower molecular weight, into sugar oligomers such as cyclodextrins or down to disaccharides such as maltose. The second common alternative to improve the solubility is chemical modification of the hydroxyl functions in

glucose units of which both amylose and amylopectin (starch polymer fractions) are comprised. Such chemical processes must at present be conducted in ineffective heterogeneous conditions.

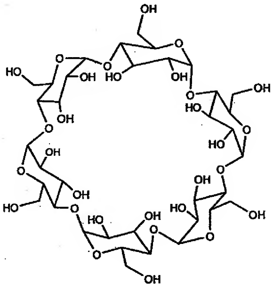
Among others, the present invention now solves all these problems by providing a homogeneous reaction media for rapid conversion of starch into its ester derivatives without any chain degradation of the polymer moiety. No additional catalysts or other chemicals (cosolvents etc.) are necessary, and the products can be prepared with high yields and in any desirable degrees of substitution.

Additionally, the separation step of the products is fast and effective and the ionic liquid media as well as the non-solvents are easily recyclable.

As noted above, Nobuo et al discloses the dissolution and subsequent esterification of both α-cylodextrin and agarose.

Structurally, a-cylodextrin is an oligosaccharide (rather than a polysaccharide) comprising six (6) glucose units, which chemical structure is described in scheme 1 below. Other common cyclodextrins comprise a ring structure consisting of either seven (7) or eight (8) glucose units.

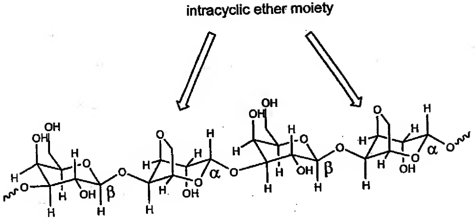
Scheme 1



Due to their low molecular weight cylodextrins are readily soluble in solvents such as pyridine, DMF, DMSO as well as water, and are commonly employed, for instance, to increase the water solubility of poorly soluble drugs for human use. Due to their good solubility, cyclodextrins are also readily both acylated or alkylated in common solvents to further enhance their properties or solubilities in different applications and solvents, inter alia. Consequently, it should be obvious to the person skilled in the art, that oligomers such as cyclodextrins are also soluble in ionic liquids.

The fact that α-cylodextrin comprises six glucose units does not indicate in any possible manner that starch comprised mostly of amylopectin having up to two million glucose units (http://www.scientificDsychic.com/fitness/carbohvdratesl .html) could be a) dissolved in an ionic liquid in the first place, and subsequently b) be subjected to any chemical transformation, in any desired degree of substitution, without chain degeneration of polymeric starch material and that the acylated starch polymer product could be easily and quantitatively separated from the reaction mixture.

The second carbohydrate cited in Nobuo et al, namely agarose, is a structural unit of natural polymer agar, which in turn consists of agarose and agaropectin. Agarose is a linear polymer, of molecular weight about 120,000, based on the -(1->3)-(3-D-galactopyranose-(l->4)-3,6 anhydro-a-L-galactopyranose unit (see scheme 2 below).



Chemical structure of agarose Scheme 2.

As with cyclodextrins, agarose is also soluble in water, DMSO, etc. It has a relatively low molecular weight, especially when compared to the starch main component, amylopectin. Additionally, it has a linear structure opposite to the branched structure of amylopectin. Moreover, the chemical structure is dramatically different compared to the corresponding structure of starch polymer components. It differs in the nature of glucoside bonds, but above all, in those intracyclic ether moieties present in every second galactopyranose unit. This moiety could practically be achieved by intracyclic etherification of two free hydroxyl groups in every second galactopyranose unit. Such a structural change in starch would diminish the amount of free hydroxyl groups present in starch by 33%. This structural change (DS =1) would in turn enhance dramatically the solubility of the resulting derivative in different solvents by making it simply more hydrophobic.

In contrast to the present invention, there is no explicit disclosure provided by the reference for either possible starting material concentrations, reaction conditions or the separation step of the products. All these features have a great economical and environmental effect, when determining the feasibility of the provided techniques.

Taking the above into account, Nobuo et al does not disclose or suggest that a person skilled in the art would, facing the same technical problem, apply these features to a giant sized starch polymer in order to obtain an esterification process to achieve the corresponding effect.

The Swatloski et al reference is well-discussed at page 6 of the specification. The reference is directed to dissolving cellulose in various ionic liquids, particularly under microwave irradiation, and precipating pure cellulose from the solution by use of selected solvents. As explained in the response to the Written Opinion, and also at the instant specification (pages 1-2), normal starch comprises amylose and amylopectin. The primary component is amylopectin, which is a large molecule with a branched structure having a molecular weight from one to several million. By contrast, cellulose is a linear polymer having a considerable smaller molecular weight – typically being a few hundred thousand. Further, the glucoside bonds of cellulose are different from those of amylopectin/amylose. It is generally thought that as the molecular weight of polymers increases, the more difficult it is to dissolve the same in a solvent. Thus, based on the teachings of Swatloski et al, it is not obvious that starch could be dissolved and esterified in an ionic solvent.

Swatloski et al discloses a method for esterifying starches in dry conditions (moisture content preferably under 2% by weight) by subjecting a mixture of starch and esterifying agent (carboxylic acids or corresponding anhydrides) to microwave energy. Due to the homogeneous reaction phase, higher degrees of substitution are achieved.

Swatloski et al explicitly teaches the necessity of microwaves in order to achieve higher conversion rates and shorter reaction times in conditions, where high reaction temperatures causing starch pyrolysis (chain degradation) may occur (p.1, lines 70-82). Contrary to the teachings of Swatloski et al, the present invention does not require the use of microwaves in order to achieve the

superb results in starch esterification. This is fully supported by all the examples of the present invention, wherein all the reactions are conducted without any microwave assist.

Swatloski et al does not give any kind of indication or teaching that the starch esterification could be conducted in homogeneous phase, or in ionic liquids or in any other solvents. This is naturally based on the knowledge, which as also taught by Swatloski et al, that starch is practically insoluble in any other solvents than water, which in turn cannot be employed as a solvent in esterifications. On the contrary, it teaches in every single example (I-VIII) that colloidal silica is employed as an assisting substance in order to reach the appropriate fluidity of the heterogeneous reaction mixture.

Further, Swatloski et al unambiguously teaches that all the esterification reactions should be conducted above 120 °C (claim 7) and that the reactions only take place at temperatures reaching 140 °C and higher (page 2, lines 123-130 and page 3, lines 1-2). Quite to the contrary, the present invention explicitly teaches the complete and fast dissolution of starch followed by an efficient esterification step can be conducted under 100 °C (page 13, line 1 and all eight examples).

Swatloski et al does not disclose any examples of utilization of acid anhydrides frequently employed in the present invention. One of the examples describing the esterification of starch deals with preparation of starch phosphate esters with phosphoric acid (example IV), the second featuring maleic acid with ammonia as a catalyst (example VII). The present invention claims the preparation of organic starch esters with an organic esterifying agent (claim 1). Phosphoric acid is an inorganic acid. Further, in the present invention no catalysts are necessary, the esterifications being preferably carried out without a catalyst (page 9, lines 1-2).

Based on the above distinctions, Swatloski et al fails to disclose any such indication or teaching that a person skilled in the art would, facing the same technical problem, apply these

features to a giant sized starch polymer in order to obtain an esterification process to achieve the corresponding effect.

The combined teachings of the two references does not result in the claimed invention. Nobuo et al relates to esterification of a sugar oligomer (α-cylodextrin) and a drastically less hydrophilic polysaccharide with low molecular weight (agarose). Both of these substrates have relatively good solubilities in water and other common solvents, and their modification in homogeneous media is commonly known. Thus, it is not surprising that Nobuo et al have selected these two carbohydrates as their starting materials. There is no indication or teaching that polysaccharides such as starch could be dissolved in any manner, and even more, in a workable manner into ionic liquids, and that this starch solution could be subjected to any chemical reactions followed by successful separation of the products.

Swatloski et al relates to chemical modification of starch in heterogeneous conditions, the main feature being the use of microwaves enabling the reactions to proceed with somewhat acceptable results. The reference explicitly teaches how to produce these cumbersome reactions with diverse solutions such as adding colloidal silica into the reaction mixture in order to enhance the workability of the heterogeneous mixture. Swatloski et al does not give any indication that it would be possible to conduct these reactions in homogeneous reaction conditions or effect the reaction rates and/or yields in any other manner but with microwaves.

The combined teachings of the cited prior art accordingly cannot result in the claimed invention. The rejection should accordingly be reconsidered and withdrawn.

The application is accordingly believed to be in condition for allowance, and an early indication of same earnestly is solicited.

Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact Raymond C. Stewart, Reg. No. 21,066 at the telephone number of the undersigned below, to conduct an interview in an effort to expedite prosecution in connection with the present application.

Payment in the amount of $460.00 is submitted herewith as payment for the requested two month extension of time.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37.C.F.R. §§1.16 or 1.14; particularly, extension of time fees.

Date: APR 15 2008

Respectfully submitted,

By Raymond C. Stewart #21,066

~~Gerald M. Murphy, Jr. Reg. No. 28,977~~
Registration No.: 21,066
BIRCH, STEWART, KOLASCH & BIRCH, LLP
8110 Gatehouse Road
Suite 100 East
P.O. Box 747
Falls Church, Virginia 22040-0747
(703) 205-8000
Attorney for Applicant